includes an insulating material layer **1300** covering the dielectric change layer **1400**, and the light-emitting structures **1211**, **1212**, and **1213** are embedded in the insulating material layer **1300**. A driving circuit **1110** for controlling voltages applied to the plurality of nanoantennas NA**1**, NA**2**, NA**3**, and NA**4**, respectively, is further disposed on the substrate **1105**.

[0114] The backlight **1100** provides light that is to be modulated in the optical modulating device **1700**. The light provided by the backlight **1100** may supply optical energy to the light-emitting structures **1211**, **1212**, and **1213** provided in the optical modulating device **1700**, and may generate an emitter. The backlight **1100** may provide ultraviolet light (UV) or light of a blue color. A light-emitting wavelength in the light-emitting structures **1211**, **1212**, and **1213** is greater than a wavelength of the light provided by the backlight **1100**. Light-emitting power of the emitter generated in each of the light-emitting structures **1211**, **1212**, and **1213** is determined by an LDOS formed according to a change of permittivity of the permittivity change layer **1400** of the optical modulating device **1700**. The change of permittivity may be controlled by an applied voltage.

[0115] The optical apparatus **1000** further includes a controller **1800** to separately control voltages applied between each of the plurality of nanoantennas NA**1**, NA**2**, NA**3**, and NA**4** and the permittivity change layer **1400**. Accordingly, the light-emitting structure **1211** between the nanoantennas NA**1** and NA**2**, the light-emitting structure **1212** between the nanoantennas NA**2** and NA**3**, and the light-emitting structure **1213** between the nanoantennas NA**3** and NA**4** may indicate different LDOSs and may serve as separate pixels that are separately controlled.

[0116] The optical apparatus **1000** may serve as a display apparatus. To this end, sizes and materials of light-emitting particles of the light-emitting structures **1211**, **1212**, and **1213** may be adjusted such that the light-emitting structures **1211**, **1212**, and **1213** emit light of different wavelengths. Depending on image information that is to be formed, the controller **1800** may control the voltages between each of the plurality of nanoantennas NA**1**, NA**2**, NA**3**, and NA**4** and the permittivity change layer **1400** to control on/off of each of pixels to display the image. The image formed as such may have high color purity, and thus, may represent improved color gamut and high contrast.

[0117] The optical apparatus **1000** may be used not only as the display apparatus but also as other apparatuses. For example, the optical apparatus **1000** may be used as a beam deflector or a beam shaper by forming the plurality of nanoantennas NA**1**, NA**2**, NA**3**, and NA**4** as shapes having different directionalities, or giving rules to voltages applied thereto.

[0118] The light-emitting structures **1211**, **1212**, and **1213** are illustrated as light-emitting particles. However, the light-emitting structures **1211**, **1212**, and **1213** are not limited thereto. The semiconductor PN junction structure or the semiconductor quantum well structure illustrated in FIGS. **14** and **15**, respectively, may be implemented as the light-emitting structures **1211**, **1212**, and **1213**. In addition, various materials and structures having photoluminescence may be used as the light-emitting structures **1211**, **1212**, and **1213**.

[0119] It is illustrated that the optical modulating device **1700** of the optical apparatus **1000** is realized by arraying the structure of FIG. **13**. However, it is not limited thereto. For example, the optical modulating device **1700** may be realized by repeatedly arraying the structure of FIG. **1**. In this case, the shape of the backlight **1100** may be changed to be more appropriate for providing light to the light-emitting structures **1211**, **1212**, and **1213**.

[0120] The optical modulating devices **100** through **108** and **1700** described above include a nanoantenna NA, a permittivity change layer, and a light-emitting structure, and may modulate incident light as various shapes by using an area in the permittivity change layer, in which a carrier concentration changes, as a gate.

[0121] Also, energy of the incident light is absorbed in the light-emitting structure of the optical modulating device so that light of different wavelengths may be emitted, and light-emitting energy may be controlled by adjusting a permittivity of the permittivity change layer.

[0122] The optical modulating devices **100** through **108** and **1700** may be miniaturized and high speed driving may be possible, and thus, the optical modulating devices **100** through **108** and **1700** may be applied to various optical apparatuses to improve the performance of the optical apparatuses.

[0123] The optical modulating devices **100** through **108** and **1700** may realize a display apparatus, together with a backlight, and may provide an image having miniaturized pixels and improved contrast.

[0124] The foregoing exemplary embodiments are examples and are not to be construed as limiting. The present teaching can be readily applied to other types of apparatuses. Also, the description of the exemplary embodiments is intended to be illustrative, and not to limit the scope of the claims, and many alternatives, modifications, and variations will be apparent to those skilled in the art.

What is claimed is:

1. An optical modulating device comprising:

a permittivity change layer having a variable permittivity;

a dielectric layer disposed on the permittivity change layer;

a nanoantenna disposed on the dielectric layer; and

a light-emitting structure disposed adjacent to the permittivity change layer.

2. The optical modulating device of claim **1**, wherein the light-emitting structure is configured to emit light having a greater wavelength than light incident on the light-emitting structure in response to the incident light, as an excitation source.

3. The optical modulating device of claim **1**, wherein the light-emitting structure comprises light-emitting particles.

4. The optical modulating device of claim **3**, further comprising an insulating material layer on which the permittivity change layer is disposed, the light-emitting particles being embedded in the insulating material layer.

5. The optical modulating device of claim **1**, wherein the light-emitting structure comprises a semiconductor quantum well or a semiconductor PN junction.

6. The optical modulating device of claim **1**, further comprising a metal layer on which the light-emitting structure, the permittivity change layer, the dielectric layer, and the nanoantenna are sequentially disposed.

7. The optical modulating device of claim **1**, further comprising a voltage-applier configured to apply a voltage between the permittivity change layer and the nanoantenna.